# THE ANATOMY OF THE INDIAN ELEPHANT. By L. C. MIALL, *Professor of Biology in the Yorkshire College, and Curator of the Leeds Museum;* and F. GREENWOOD, *Curator to the Leeds School of Medicine.*[1] (PLATES II. to V.)

## PART III.

IN dealing with the myology of the Elephant, we thought it advisable, considering the want of any tolerably complete description, to note every important detail which came to light in the course of our dissection. It would be superfluous to treat all parts of the anatomy with the same fulness. The osteology, for example, has long been amply made known, nor would any student value minute descriptions of bones which can be so easily seen and handled. Other parts of the anatomy are known in various degrees of completeness; some thoroughly, some superficially, some hardly at all. Vulpian and Philipeaux have published a lengthy and elaborate description of the heart; Dr Morrison Watson has minutely described the male organs of generation, and other important viscera; the brain has been figured more than once; while scattered memoirs contain particulars of greater or less value respecting other organs. Under these circumstances we shall probably employ our space and the reader's time to the best advantage by a summary of what is already known, corrected and supplemented by our own observations. Although such anatomists as Cuvier, Camper, and Hunter have preceded us, there is still much to be gleaned, more than any single exploration of the field is at all likely to discover.

The osteology and dentition we propose to leave out altogether. Common text-books already contain descriptions sufficient for the naturalist or palæontologist.

## ALIMENTARY CANAL AND ITS APPENDAGES.

### MOUTH.

The gape of the mouth is small relatively to the bulk of the animal,—a fact which may receive explanation from the precision with which food is passed into the mouth by the proboscis, and the small part which the lips consequently play in the act of prehension. The upper lip has hardly any separate development, but seems a mere lateral expansion of the root of the trunk; the lower lip is small and pointed, its mucous surface

[1] Continued from vol. xii. p. 400.

forming a narrow groove or gutter in which the tongue is lodged. The cheeks are very capable of distention, but in their ordinary contracted state they enclose only a very small cavity.

The mucous membrane of the mouth is in general smooth; that of the palate in particular is quite smooth, and shows none of the transverse ridges which appear on the hard palate of the horse and ox. Two shallow triangular depressions placed symmetrically immediately in front of the fore edge of the hard palate lead to Jacobson's canals. The bony cavity in which the canals lie runs in the suture between the premaxillæ and maxillæ for 7 or 8 inches (Mayer gives 8 inches), taking a nearly straight direction upwards and backwards; it is furnished with a vertical cartilaginous septum and a cartilaginous lining. Each of the component canals is of about the diameter of a goose-quill, and is lined by an extension of the mucous membrane of the mouth. Camper (p. 48) says that these canals when pressed exude a sticky fluid.

Examination of skulls of different ages seems to show that Jacobson's canals are at first nearly horizontal, but that as the air-cells of the maxilla enlarge, the maxillo-premaxillary suture, and with it the canals, is tilted more and more, until it finally gets a steep slope forwards.

## Tongue.

The tongue is thick and rounded towards its base, tapering and pointed in front. Perrault describes it as 18 inches long, but in our young example it was much shorter. The tip is directed downwards, and lies almost invariably in the groove formed by the lower lip. All observation of the living animal seems to show that the tongue, like the lips, is of little importance in the act of feeding. The oral surface of the tongue ends behind in a prominent concave edge, which forms the front and lower boundary of the pharyngeal pouch. Towards the base are two, four, or more circumvallate papillæ of large size, while on the side, especially behind, are a number of wart-like eminences and mucous crypts.

## Salivary Glands.

The parotid was small in our example, and measured only

4 inches by 3. Dr Watson gives 8 inches by 5 as the dimensions. The gland is connected by a fibrous band with the zygoma; it lies in the space below the zygoma and behind the ascending ramus of the lower jaw. Steno's duct passes out from near the middle of the gland; it is at first of about half an inch diameter, but gradually contracts to the size of a crow-quill. Close to its termination it pierces the *buccinator*, and finally opens into the mouth near the alveolar margin of the upper jaw by a simple rounded orifice without papilla.

No sub-maxillary gland was seen either by Dr Watson or ourselves, though it is described by Mayer. A small lobulated mass, lying between the *genio-hyo-glossi* and close to the symphysis of the mandible, may possibly be a sublingual gland, but we were unable to discover an efferent duct, or to satisfy ourselves as to the exact nature of the body.

## Soft Palate.

The soft palate, which is hardly distinguishable from the base of the velum palati, extends backwards about 2 inches from the hind edge of the hard palate. Like the nasal passages immediately above, it is narrow from side to side. No *levator palati* was made out. The *tensor palati*[1] arises from the front and outer side of the upper part of the membranous section of the Eustachian tube. It is a small, spindle-shaped muscle enclosed in a sheath of fascia. At the groove of the hamular process it becomes tendinous and spreads out in the substance of the soft palate.

## Pharynx.

The upward extension of the pharynx towards the nasal passages gradually narrows from side to side as it ascends. The antero-posterior dimension is much contracted in the neighbourhood of the soft palate. Above this level, the pharynx is prolonged into the nares in front, and is also continued for some distance backwards as a gradually diminishing cavity which extends beneath the basi-sphenoid to near its junction with the basi-occipital. The ultimate recess (the sinus of Morgagni) just admits the last joint of the forefinger.

[1] Dr Watson considers that this muscle is absent in the elephant.

The pharyngeal openings of the Eustachian tubes lie in the lateral walls of this part of the pharynx, about an inch above the hamular pterygoid process, and a little above the level of the hard palate. The orifices are large enough to admit the little finger. In its lower part each tube is almost entirely membranous. It runs upwards and a little outwards, and may be explored by a probe for 7 inches. We have been unwilling to destroy the surrounding parts for the sake of tracing the tube further. According to Camper's figures (pl. xiii. figs. 7, 8), the bony tube is about 2 inches long and the cartilaginous tube over an inch. The same author describes and figures an opening from the upper part of the cartilaginous tube into the nasal passage. We find no corresponding opening in the soft parts.

The common aperture of the posterior nares occupies a triangular space $4\frac{1}{2}$ inches high and 2 inches wide. The hind edge of the septum is very thin, and deeply concave above.

*Muscles of the Pharynx.*

*Constrictor pharyngis* arises on each side from the thyro-hyal, from the posterior margin of the thyroid cartilage, and from the cricoid cartilage below the arytænoid facet. The fibres pass round the tube of the pharynx, and blend along the middle line behind. The uppermost (or anterior) fibres form a tolerably distinct bundle. The lower fibres curve upwards so as to leave a triangular gap, which is filled by a tapering median bundle of the longitudinal œsophageal fibres.

C. and L.—261, fig. 1 ($s^1$, $x^2$, $z^2$).

*Stylo-pharyngeus* arises from the internal surface of the anterior branch of the stylo-hyal, close to its origin. The muscle passes downwards along the side of the pharynx and is there inserted.

C. and L.—261, fig. 1 ($v^1$).

*Palato-pharyngeus* is largely developed. It arises from the palate and descends to the pharynx, forming a considerable part both of the soft palate and the velum palati. It is inserted laterally on the inner surface of the pharyngeal wall.

A symmetrical venous plexus, which arises by free communications between the internal jugular, internal maxillary, and inferior palatine veins, lies at the back of the mouth, below the soft palate.

The entrance to the pharynx is bounded above by the antero-inferior edge of the velum palati (where its descending and horizontal portions meet); in front and below by the sharp, backward directed edge of the dorsum of the tongue; and laterally by the mucous membrane of the pharynx, with which are connected a number of scattered muscular fibres, and the yellow elastic pharyngeal wall. There is no *palato-glossus*. The passage is very narrow, and cannot in our young example be distended to admit a cylinder of 2 inches diameter.

The velum palati descends from the soft palate, but its chief extension, as in many other large quadrupeds, is horizontally backward. The free posterior edge passes so far back as slightly to overlap the epiglottis. On each side it is continued into a thin elastic fold, which is obliquely attached to the pharyngeal wall, sloping backwards. In the natural position of the parts, the posterior edge of the velum encloses an oval space, the longitudinal diameter being an inch and a half, the transverse somewhat less. Through this aperture the arytænoid cartilages project. The lower ends of the lateral bands of the velum are approximated, but they do not meet; and Dr Watson, therefore, in speaking of the "central" aperture of the soft palate, is to be understood as meaning "in the middle line." The position of the aperture is anatomically the same as in the human subject or as in the majority of mammalia, and altogether below the velum. There is no uvula, but we find a small vertical muscle in the middle line, passing from the soft palate, to be inserted into the back of the upper portion of the velum. This may represent an *azygos uvulæ*; its length does not exceed 2 inches.

The muscular layer of the velum palati forms part of the *palato-pharyngeus*. Its anterior fibres, arising from the palate, pass backwards and a little downwards, to be inserted into the inner surface of the elastic wall of the pharynx, near the free tip of the thyro-hyal. The posterior fibres gradually take a more and more transverse direction, and form the thin muscular sheet which lies in the horizontal valve of the velum. The lateral bands of attachment contain muscular bundles from the same stratum. These bands are separated from the insertion of the anterior fibres of the *palato-pharyngeus* by a considerable elastic pouch, opening backwards into the pharynx, and lined by a continuation of the mucous membrane of that cavity.

Immediately in front of the epiglottis is a vertical transverse elastic fold, which projects from the floor, and especially from the sides, of the pharynx, but not so far as to materially obstruct the passage. Smaller secondary folds proceed backwards from this at right angles, passing longitudinally upon the floor of the pharynx outside the laryngeal aperture. When the pharynx is seen from above and behind, there are therefore visible three cavities on each side, divided from each other by mucous folds. In front of the epiglottis, behind the transverse fold, and inside the longitudinal secondary fold just described, is a small recess, with a small gland in its floor. To the outer side of this is a larger cavity, in which a larger gland can be seen; it is included between the transverse fold, the secondary longitudinal fold, and the lateral attachment of the velum. Between the lateral attachment of the velum and the proper pharyngeal wall is a third and much more capacious receptacle, which has been described in connection with the *palato-pharyngeus.*

The wall of the pharynx is largely composed of yellow elastic tissue, overlaid by the constrictor muscles. The *palato-pharyngeus* lies deeper, and is inserted into the inner surface of the elastic wall.

Dr Watson has described, in connection with the pharynx, a peculiar structure which throws light on a previously unexplained faculty of the elephant, viz., the power which the animal possesses, according to more than one competent observer, of withdrawing large quantities of water by inserting the tip of the trunk into the mouth. He observes that

"It is evident that were the throat of this animal similar to that of other mammals, this [withdrawal by the trunk] could not be accomplished, as the insertion of a body, such as the trunk, so far into the pharynx as to enable the constrictor muscles of that organ to grasp it, would at one give rise to a paroxysm of coughing, or were the trunk merely inserted into the mouth, it would be requisite that this cavity be kept constantly filled with water at the same time that the lips closely encircled the inserted trunk. The formation of the mouth of the elephant, however, is such as to prevent the trunk ever being grasped by the lips so as effectually to stop the entrance of air into the cavity, and thus at once, if I may so express it, the pump-action of the trunk is completely paralysed. We find, therefore, that it is to some modification of the throat that we must look for an explanation of the function in question, and this we find to be as follows:—The superior aperture of the pharynx (fig. 1, A) is extremely narrow, so much so as to admit with difficulty of the passage of the closed fist. Immediately posterior to this narrow aperture the pharynx dilates into a pouch of large size (fig. 2, E), capable of containing a considerable quantity of fluid. This pouch is prolonged forward beneath the root of the tongue, and is bounded in the following manner. The floor extends from the epiglottis as far forward as the root of the tongue, being formed from behind forward by the thyroid cartilage, thyro-hyoid membrane, and hyoid bone. Its lateral walls are completed by the sides of the pharynx (that is, by the superior constrictor muscles—fig. 2, F), in addition to the stylo- (G), and hyo-glossi (H) muscles. The root of the tongue forms the anterior boundary, whilst the posterior wall is completed by depression of the soft palate, or when the latter is elevated, the pouch then communicates freely with the œsophagus. In connection with this pouch is to be observed the very peculiar form of the hyoid bone, which, being deeply concave on its upper surface, forms as it were the greater part of the floor of this pouch. Between the pouch and the concavity of the hyoid bone, moreover, there is placed a large quantity of loose and distensible connective tissue, which permits of the expansion of the pouch. The size of the latter is, moreover, liable to alteration by the actions of several muscles. These are more especially the hyo-glossi muscles, and two little additional muscles (fig. 2, K), the homologies of which I have not yet been able to determine, which, springing from the middle line of the hyoid bone, in front of the pouch, pass up, one on either side of the middle line, and blend with the other muscles forming the root of the tongue. By the action of these muscles the pouch may be diminished in *depth;* but in consequence of the narrow interval existing between the hyoid cornua, the *length* of the pouch from before

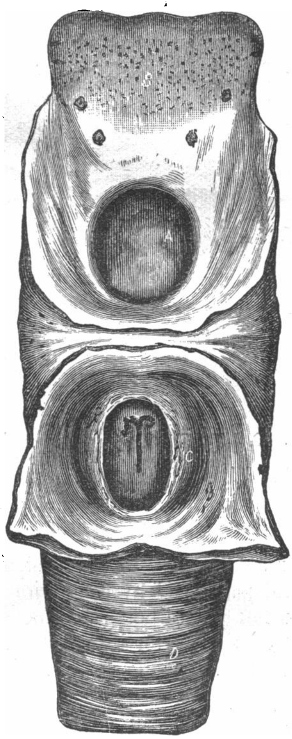


FIG. 1.—A, superior aperture of pharynx. B, root of tongue. C, soft palate with larynx projecting through the centre. D, pharynx.

backwards cannot be altered, as the thyroid cartilage is thereby prevented from being approximated to the hyoid bone. . . . An elephant can, as the quotations sufficiently prove, withdraw water from his

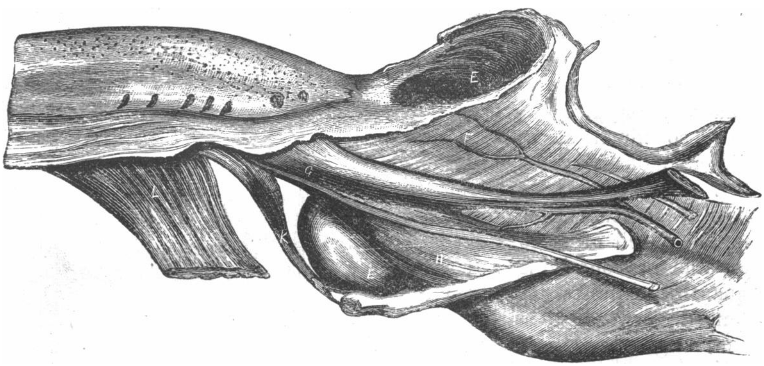


Fig. 2.—E, E, pharyngeal pouch. F, superior constrictor. G, stylo-glossus. H, hyo-glossus. K, small muscle, which diminishes the depth of the pharyngeal pouch. L, genio-glossus muscle. (For the use of the woodcuts of figs. 1 and 2 we are indebted to Professor Turner.)

stomach in two ways: first, it may be regurgitated directly into the nasal passages[1] by the action of the diaphragm and abdominal muscles, the soft palate being at the same time depressed, so as to prevent the entrance of water into the mouth. Having in this manner filled the large nasal passages communicating with the trunk, the water contained in them is then forced through the trunk by means of a powerful expiration; or, in the second place, the water may be withdrawn from the cavity of the mouth by means of the trunk inserted into it. Now, in this case, it is manifestly impossible that the water can be contained within the cavity of the mouth itself, as I have already shown that the lips in the elephant are so formed as effectually to prevent this. The water regurgitated is, however, by means of the elevation of the soft palate, forced into the pharyngeal pouch. The superior aperture of this pouch being much narrower than the diameter of the pouch itself, and being completely surrounded by the muscular fibres of the stylo-glossus on each side, and the root of the tongue in front, which is prolonged backwards so as to form a free sharp margin, we have thus as it were a narrow aperture surrounded by a sphincter muscle, into which the trunk being inserted and grasped above its dilated extremity by the sphincter arrangement just referred to, air is thus effectually excluded, and the nasal passages being then exhausted by the act of inspiration, water is lodged within these passages to be used as the animal thinks fit, either by throwing it over his body, or again returning it into his mouth."

[1] For remarks on this passage see p. 48.

The chief difficulty attending this explanation springs from the small size of this pharyngeal pouch. In our example, which, it must be remarked, was by no means of full stature, the pouch could not be distended so as to hold a pint of water. This objection is not fatal to the hypothesis advanced by Dr Watson.[1] Regurgitation from the stomach may be effected slowly and continuously until the requisite supply is yielded. It seems to us that the pharyngeal pouch must be unimportant as a mere reservoir of fluid, but as a water-tight circular valve it may be essential to the process of withdrawal. Behind the velum palati is a somewhat larger cavity, but the entrance to the windpipe lies in its floor, and this is not therefore a very likely receptacle of fluid. If our examination of an immature elephant yields data in the least trustworthy, it is hard to suppose that even in the adult a gallon of water can be retained anywhere between the stomach and the proboscis.

We do not know enough of the habits of the living animal to say whether or not the food is moulded and lubricated into a bolus, but the form, structure, and glandular surface of the pharyngeal pouch would be well adapted to such a practice.[2]

[1] Dr Watson informs us that he considers the pharyngeal pouch unimportant as a mere reservoir, "though the presence of certain muscles not found in other animals would appear to indicate that the elephant possesses a certain power of increasing or diminishing the size of the pouch, and the necessity for this is by no means evident upon the supposition that the sphincter arrangement is the only *raison d'être* of this pouch."

[2] Professor Owen describes the back of the mouth of the Camel in these words: —"A broad pendulous flap hangs down from the fore part of the soft palate, and usually rests upon the dorsum of the tongue. The velum palati extends beyond this process some way down the pharynx, and terminates by a concave border. The pharynx behind the velum dilates into a sac. In the rutting male the palatal flap is greatly enlarged. I have found it extending 10 inches down the pharynx, passing below the margin of the soft palate and the opening of the larynx, into the œsophagus: in the living animal it is, at this season, occasionally protruded, with a belching noise, from the mouth. Its surface shows the pores of innumerable mucous crypts, and in the ordinary state, in both sexes, the flap may apply its own secretion, and water regurgitated from the storage cells of the stomach to the extended surface of the pharynx and root of the tongue so as to allay the feeling of thirst and help the animal to endure the long remissions of drinking to which it is liable in traversing the desert" (*Comp. Anatomy of Vertebrates*, vol. iii. p. 395). In transcribing these remarks, we desire to offer no opinion as to the validity of the explanation offered. The pharyngeal sac described in the camel may throw light on the similar structure in the elephant.

A number of pits in the mucous membrane of the floor and sides of the pharynx are doubtless glandular. They are altogether absent from the middle line, but become densely aggregated towards the root of the tongue on the sides of the pharyngeal floor. Similar glandular crypts line a pouch, in our example about an inch deep and half an inch in diameter,[1] which lies on each side in the lateral wall of the pharynx in front of the transverse fold described above. In the lateral spaces behind the transverse fold are other flattened glands.

The thyro-hyals support the pharyngeal wall laterally, and their expanded ends can be plainly felt upon its inner surface, in the recess behind and within the lateral attachment of the velum. Professor A. H. Garrod has remarked[2] that the basi- and thyro-hyals form a lower arch quite distinct from the bifurcate stylo-hyals, and he adds: "In the elephant, therefore, the deficiency of the lateral intermediate elements of the hyoid apparatus permits of a much greater movement of the base of the tongue than in the ungulata, whose nearly rigid stylo-hyals, epi-hyals and cerato-hyals can allow of little more than an antero-posterior movement of the base of the tongue in part of the circle of which the hyo-cranial attachment in the centre."

## Œsophagus.

Dr Watson states that "the muscular fibres of the œsophagus are distinctly striated even down to the œsophageal opening in the diaphragm, and are arranged in two layers—an external, the fibres of which are distinctly longitudinal in direction; and an internal, which consists of two sets of spiral fibres, one of which passes from right to left, whilst the other passes in the opposite direction, and thus gives rise to a decussation of the fibres at all points."

Like Dr Watson, we found no trace of a muscle connecting the trachea with the œsophagus and stomach, such as was described and figured by Dr Harrison of Dublin.[3]

[1] Mayer found this pouch to be 3½ inches long and 1½ wide.
[2] *Proc. Zool. Soc.* May 1875.
[3] *Proc. Roy. Irish Acad.* vol. iv. p. 133 (1847).

## Stomach.

An excellent figure of this viscus is given by Camper (pl. ix. fig. 1). Mayer's drawing is less satisfactory.

The stomach is smooth externally, elongate, and nearly straight. The cardiac end is much prolonged and tapering. A number of transverse nearly circular folds project inwards from the cardiac wall; they almost disappear when the stomach is greatly distended, and are at all times too shallow to serve as water-cells, though they have been figured and described as such.[1] The gastric follicles are most abundant towards the cardiac end, as Mayer has observed. In an adult elephant the stomach is little less than three feet long; the œsophagus enters near the middle but rather nearer the cardiac than the pyloric end. The pyloric valve is well developed.

## Intestines.

"The duodenum is at first loosely suspended and convolute, as in some rodents; it is more closely attached at its termination. The mucous coat of the jejunum is thrown into small irregular folds, both transverse and longitudinal. There are oblong patches of agminate follicles. The termination of the ileum projects as a conical valve" [a very truncate cone] "into the cæcum. The longitudinal layer of muscular fibres is continued directly from the ileum upon the cæcum; but the circular layer accompanies the valvular production of the mucous membrane, and is there thicker than on the free gut. The large cæcum is sacculated on three longitudinal bands, which are continued some way along the colon."[2]

We find a number of aggregated glands, not unlike Peyer's patches, in the rectum. The occurrence so low down of what are probably absorbents may be partly explained by the slow alteration of food passed along the alimentary canal of the elephant. Even in the large intestine the original form of many pieces of vegetable food is retained, and grains of maize were recognisable in the colon of our example, as were hay and potatoes in the colon of that dissected by Camper.[3]

[1] Emerson Tennent, *Natural History of Ceylon*, p. 125; see also Perrault, as quoted by Buffon, *Hist. Nat.* vol. xi. p. 109.

[2] Owen, *Comp. Anat. of Vertebrates*, vol. iii. p. 457.

[3] Further observations are necessary before we can be satisfied that these appearances are not due to disease.

Hunter gives 17 feet as the length of the small intestine. Mayer makes it 37 feet, while he gives the total length of the intestines as 75 feet. Professor Owen's measurements, taken from a young Indian elephant about 7 feet high at the shoulder, are as follows[1]:—

| | Ft. | In. |
|---|---|---|
| Length of the small intestines, . . | 38 | 0 |
| Circumference of ditto., . . . . | 2 | 0 |
| Length of cæcum, . . . . . | 1 | 6 |
| Circumference of cæcum, . . . | 5 | 0 |
| Circumference of colon, . . . . | 6 | 0 |
| Total length of colon and rectum together, . . . . . . . | 20 | 0 |
| Total length of intestinal canal, exclusive of the cæcum, . . . . . . | 58 | 6 |

Our own measurements have unfortunately been mislaid, which is the more to be regretted that the statement of previous observers are very discordant.

## Peritoneum.

Hunter has remarked that the lymphatics and lacteals are small. He found no lymphatic glands on the mesentery proper; there were several on the meso-colon, but these were not larger than in man.

"The peritoneum lining the elastic ventral wall of the abdomen in the elephant and rhinoceros is of unusual thickness and strength; the areolar tissue connecting it to adjacent structures presents aponeurotic firmness; the free surface of the serous membrane I found to be white and opaque; it is generally transparent and opaline or colourless."[2] The absence of fat from all parts of the peritoneum has been remarked by more than one dissector of the elephant. In our example the great omentum was quite clear of fat, as indeed were all parts of the body, except the fibrous pads of the soles of the feet and the orbits.

[1] *Comp. Anat. of Vertebrates*, vol. iii. p. 458.

[2] Owen, *Comp. Anat. of Vertebrates*, vol. iii. p. 503.]

### Liver.

The liver is divided by the suspensory fissure into two lobes, of which the right is the larger. There is no gall-bladder, but the ductus cholædocus expands in the wall of the duodenum into a sacculated pouch, which receives also the secretion of the pancreas. The termination of the duct projects slightly into the small intestine, and is surrounded by a sphincter.

### Pancreas.

The pancreas of the elephant differs little from that of most mammals; it does not reach the spleen.

### Spleen.

The spleen is long and flat, broader in the centre than elsewhere, and occupies its usual position.

## MALE GENERATIVE ORGANS.

Dr Morrison Watson's account of the male organs of the elephant,[1] evidently founded upon a careful dissection, but neglecting no advantage which is to be derived from the comparison of earlier descriptions, is probably the best accessible, and we may refer the reader to it for particulars of the arrangement.

It will be of interest to give here some passages from a letter of Dr William Ogle, in which are quoted the first extant accounts of the anatomy of the elephant. The description of the generative organs seems to imply actual dissection by some ancient anatomist.

"Aristotle most probably, as I think, never saw an elephant himself, but the following passages from his *Historia Animalium* show that even at that early time some one or other either had or professed to have examined the inside of one.

"II. 17. 'The elephant's intestine is formed of parts so put together as to give the appearance of there being four stomachs. Its viscera resemble those of the hog, but are of course much larger. The liver, for instance, is four times as large as that of an ox. The spleen, however, is of small size, considering the large bulk of the animal.'

"II. 1. 'The penis of the elephant is like that of the horse, but small considering the animal's bulk. The testes are not visible externally, but are placed inside, near the kidneys. The pudendum of

[1] *Journ. of Anat. and Phys.* vol. iii. p. 65 (1872).

the female is placed in the position which in ewes is occupied by the dugs, but for congress is drawn upwards and directed outwards, so as to facilitate the action of the male. It has naturally a wide orifice.' "

## FEMALE GENERATIVE ORGANS.

### OVARY.

The ovary in our young example was about one-third larger than in the adult human female, deeply corrugated on the surface, and of a flattish oval figure. Many immature Graafian follicles were distinguished.[1]

### FALLOPIAN TUBES.

The commencement of each Fallopian tube lies within a somewhat capacious pouch, which holds 3½ ounces of water when distended. The fimbriæ expand over the membranous walls of the pouch, and project as ridges from the inner surface. The outer surface is covered with peritoneum. Scattered muscular fibres (unstriped), together with vessels and nerves, lie in the membrane. The ovary lies, not in the fimbriated pouch itself, which directly communicates with the Fallopian tube, but in a separate compartment, lined with peritoneum, in whose wall the fimbriated pouch may be said to be excavated. A valve or membranous fold separates the two cavities. On the side of this valve, remote from that part of the pouch which ordinarily lodges the ovary, the Fallopian tube may be seen, expanding to its orifice. In the opposite direction it rapidly contracts to a long, narrow, and tortuous canal, which suddenly expands again to an outside diameter of about half an inch. From this point each of the cornua uteri converges towards its fellow, running parallel therewith for the last 3 inches of its course, and opening finally into the common uterus. The total length of each is about 14 inches. A number of uterine glands are visible towards the lower end of the cornua.

### UTERUS.

The cornua unite to form a short tube of about an inch in

[1] Mayer describes the outer surface as smooth "and only provided with lobes (Läppchen) at its point of attachment." He says, further, that there are no projecting Graafian follicles.

length and three quarters of an inch in diameter. This leads into a somewhat larger chamber about three inches long, which represents the cervix uteri. The wall of the uterus is provided with circular muscular fibres. Outwardly the uterus is with difficulty distinguished from the vagina, but on opening the tube loose longitudinal folds of the mucous surface are found to converge towards two well-marked (anterior and posterior) internal protuberances, which nearly close the passage from one to the other, forming thus a kind of os uteri.

Dr Watson finds no constriction corresponding to an os uteri in the female of *Hyæna crocuta*, and goes on to say:— "The same remark holds good, so far as I can ascertain, of only one other placental mammal—that is, of the Indian elephant, in the female of which, as Mayer pointed out, the vagina is altogether absent, and the uterus opens directly into the urino-genital canal."[1] Mayer does not actually use this language, for he regards the uro-genital canal as vagina ("die mit der Urethra vereinte Vagina"), but the facts as described by him admit of Dr Watson's interpretation. Whether the uterus is really perfectly continuous with the vagina is another question, and here we must remark that we find much discrepancy between Mayer's account and the actual part which is now before us. Shortly below the union of the Fallopian tubes, there is visible externally a slight constriction. At the same point two considerable and well-marked enlargements project inwards from the internal wall and almost close the passage. Above this point the uterine wall is more distinctly and closely plicate than below. Hence the united Müllerian ducts appear to us to be plainly divisible (above the uro-genital canal) into two parts, which are separated by a constriction and differ in internal structure. The upper part seems to us to represent the uterus, and the lower the vagina, while the internal thickening may well represent an os uteri. It would be interesting to know something of the gravid uterus of the elephant, and in particular to ascertain by direct observation in what part of the united sexual ducts the fœtus is lodged, but we have no observations before us which bear upon this point.

[1] *Proc. Zool. Soc.* 1878, p. 424.

## VAGINA.

The next division of the generative canal may be distinguished as the vagina. It is about 9 inches long, and tapers upwards. The walls are almost entirely destitute of muscular fibres. On its inner surface a number of small and irregular rugæ are seen, some of which converge to an indistinct anterior and a posterior raphe.

## URO-GENITAL CANAL.

Close to the entrance of the urethra into the generative duct a marked constriction is externally visible, and here, when the peritoneum is removed, the outer surface, which was smooth and membranous in the region of the vagina, becomes strongly marked by circular muscular fibres. On opening the tube a narrow passage serves as the only communication between the proper vagina and the vulva, or uro-genital canal. This passage is divided into lateral halves by a thick rounded cord covered by mucous membrane, which is apparently a hymen.[1]

The uro-genital canal is more than twice as long as the proper vagina, and when freed by dissection and extended, it projects 14 or 15 inches beyond the anus. In the natural (unexcited) state the tube is curved forwards and opens on the under surface of the belly, but by distention of the crura clitoridis it can be so far straightened that the orifice looks almost directly backwards, being then beneath the anus, but separated from it by a considerable interval. Thus the urine is ordinarily discharged downwards and forwards, but sexual congress takes place in something like the position ordinary among quadrupeds.[2]

In the upper half of the uro-genital canal, above the root of the clitoris, its walls are invested by nearly circular muscular fibres, which are less distinct on the side adjacent to the rectum, and are also less developed in the lower part of this space. A strong band of muscular fibres is attached for about 2 inches

[1] It would be well to ascertain, when an opportunity occurs, whether this band is ruptured by copulation or parturition, as the descriptions of Hunter and Mayer indirectly lead us to suppose probable.

[2] Dr Watson informs us that the evidence of eye-witnesses, though not so ample or explicit as might be desired, goes to show that the female rests upon the fore-knees with the hind legs extended in the standing posture.

to the body of the clitoris, near its root, and extends upon the sides of the uro-genital canal. These fibres diverge considerably, the lower ones passing nearly transversely, while the upper ones pass upwards and forwards at an angle of about 45°. They terminate along a defined line on the intestinal side, so that the muscles of opposite sides are separated by a clear membranous space of about 2½ inches. Some of the higher fibres are continued over the side of the rectum, and become continuous with the anterior fibres of the *sphincter ani*, while a number of more scattered fibres proceed from the upper part of the uro-genital canal, and are lost upon the sides of the rectum. The last nine inches of the canal have the walls thin and comparatively membranous, but muscular fibres can be still detected, which are attached to the sides of the clitoris and surround the tube.

When the uro-genital canal is laid open, its inner surface is seen to be lined by a smooth mucous membrane. An interrupted line of dark spots is visible near the external outlet, running about an inch apart from the defined line which marks the junction of the epidermic and epithelial surfaces. Two sinuses (canals of Malpighi?) open on the superior (intestinal) wall of the canal about the middle of its course, and can be traced for about 2 inches upwards. They open towards the outlet of the uro-genital canal. No glandular bodies were discovered in connection with the sinuses. The orifice of the urethra is a simple rounded opening on the side remote from the rectum.[1]

The uro-genital outlet is not situated near the anus, but is ordinarily drawn forward, so as to reach the symphysis pubis. Its sides are very loose and do not appear to be provided with a distinct sphincter. The labia, or loose folds covered with mucous membrane, form a hood or prepuce to the prominent glans clitoridis.

## CLITORIS.

In our specimen the clitoris measured 14 inches, and the glans projected nearly 2 inches. The two diverging crura

[1] Hunter (*Essays and Observations*, vol. ii. p. 175), says that "at the termination of the proper vagina its cavity contracts at once, almost into a blind end; in the centre of which there are three small openings, neither of them larger than a crow-quill; the two lateral of these lead to two small sacs which pass a little way along the sides of the common vagina."

spring from the rami of the os pubis. Beyond this junction the clitoris is nearly cylindrical. The vessels and large nerve lie on either side, while in the middle line, enclosed in a distinct membranous sheath, is the common tendon of the *retractores clitoridis.* These consist of a pair of small tapering muscles, which unite about 5 inches below their origin in a common tendon. This passes along the dorsum of the clitoris, and is inserted into the glans. The cavernous structure of the crura clitoridis is well marked, and they can be easily inflated. The glans is terminal and semi-globular.

## ACCESSORY REPRODUCTIVE ORGANS.

The mammæ are pectoral, and two in number. They lie between the fore-legs. The two glands are contiguous, and the nipples are nearly intermediate between the middle line of the thorax and the axilla.

A temporal gland, situated above the zygoma, and half-way between the eye and the ear, may be possibly an accessory reproductive organ. It is flat, and in our example of squarish outline. It lies upon the temporal muscle, from which, however, it is separated by the temporal venous plexus. The excretory duct is short and of very small calibre, opening from the lower end of the gland. In the male and during the rutting season, a copious flow of odorous liquid is said to be discharged from the orifice. Our example was an immature female, but the gland was nevertheless well developed and conspicuous. It measured $3\frac{1}{2}$ inches by 3 inches, and weighed about two ounces.

## URINARY ORGANS.

Each kidney showed five lobes in our example, but other dissectors report various numbers, from two to eight or nine. The lobes were essentially distinct, each having its own cortical and medullary substance and a separate calyx, but the external separation was not very marked. Two or three Malpighian pyramids, hardly projecting into the calices, were found in each lobe; on the flattened apex of each the renal tubes were distinguished by the eye. The calices of the three anterior lobes united to form a common canal, which after a course of about

3 inches was joined by a similar tube formed by the union of the two posterior calices. Here the ureter was much dilated; it tapered towards the bladder for the first ·4 inches of its course, and then continued with a nearly uniform diameter to near its termination, where it suddenly narrowed. The whole length was 18 inches.

The supra-renal capsules were transversely elongate, tapering to a point on the outer side.

Comparison of different descriptions of the elephant's kidney reveals much discrepancy as to the number and distinctness of the lobes, the number of calices and their mode of entry into the ureter. The unlikeness of Camper's figure to our dissection is extreme.

The bladder presents no remarkable features. The orifices of the ureters were seven-eighths of an inch apart[1] (in our young elephant), and the orifice of the urethra was about two inches distant from them. The ureters lie for about an inch between the coats of the bladder. In the young female the urethra is about an inch long, opening on the front of the uro-genital canal close to the proper vagina.

## HEART AND VESSELS.[2]

### HEART.

The heart of the elephant has been repeatedly dissected, and may now be treated briefly. For fuller particulars the reader may consult Vulpian and Philipeaux,[3] together with the corrections and additions of Dr Morrison Watson.

The pericardium is pointed forwards, where it is united to the base of the heart. Two fibrous cords pass from the back of the pericardium to the tendinous centre of the diaphragm. Dr

[1] In Dr Watson's example the two ureters were separated by a distance of $3\frac{1}{2}$ inches, and lay for $2\frac{3}{4}$ inches in the wall of the bladder.

[2] It was our first intention (this *Journal*, vol. xii. p. 264) to omit the heart, lungs, and liver, seeing that Messrs Vulpian and Philipeaux have described them so minutely, but on comparing their account with our dissection, and with Dr Watson's notes, we find not a few discrepancies of greater or less importance. A short notice of these viscera is therefore included in the present memoir.

[3] *Ann. Sci. Nat. Zool.* 4e sér. tom. v. p. 183 (1856).

Watson finds them specially connected with the anterior of two plates of yellow elastic tissue which cover the two surfaces of the muscular portion of the diaphragm. He observes further "that the pericardiac band of the right side was entirely composed of that peculiar form of yellow elastic tissue which, so far as I am aware, has only once before been described, and that in the ligamentum nuchæ of the giraffe by Mr Quekett. In the left band, as well as in the plate into which the bands expanded, the elastic tissue presented the usual appearance." Vulpian and Philipeaux speak of the fibrous band as single.

The base of the heart is depressed forward, and the interventricular septum is nearly vertical and longitudinal. In the following remarks we shall use terms of direction and position with reference to the natural state of the parts. The base is understood to be anterior, the apex posterior, and the right auricle dorsal or superior.

With respect to the general form of the heart, the separation of the apices of the ventricles is the most important feature.[1] Vulpian and Philipeaux say: "Il n'y a pas de sillon inférieur inter-ventriculaire nettement dessìné. Il y a, au contraire, un sillon supérieur très profond, qui, du milieu de la base du cœur, se porte au voisinage de la pointe." In our example the case was almost reversed; the superior groove was shallow and unimportant, whereas the apical interventricular groove was deep and conspicuous. The right side of the heart is, so to speak, rotated upon the centre of the left; the right auricle being thrown to the dorsal surface of the heart, while the principal axis of the right side, passing directly through the auriculo-ventricular orifice, is inclined upwards, instead of lying nearly horizontal, as does that of the left side in the animal as it stands. The inferior face (anterior of man) gives no indication of this tilting of the right side, except that the right auricle is displaced; the two ventricles meet along a straight line and divide the lower surface nearly equally. Vulpian and Philipeaux found much fat at the base and on the front of the ventricles—the only instance we can recollect in which any considerable quantity of

[1] In some Cetacea the apex of the heart is indented, while in Sirenia, particularly in the dugong, the separation of the ventricles is even more marked than in the elephant.

this substance has been met with in any part of the elephant The heart dissected by us was perfectly destitute of fat.

*Right Auricle.*—The walls are thin, but strengthened by pectinated muscles above, as well as in the appendix, which is hardly separable from the general cavity. Vulpian and Philipeaux describe the wall as areolated towards the venæ cavæ, but this was not the case in our example, except behind the left anterior cava. Two anterior venæ cavæ (right and left) enter, one towards the base, the other towards the apical end, and a posterior vena cava on the dorsal and external side, somewhat in front of the left anterior cava. A sigmoid valve passes from the external side of the right anterior cava, adjacent to the appendix, curves round the ventral side of the orifice, and is then continued as a long membranous ridge of slight projection to the basal or anterior side of the posterior cava; it then crosses that opening on its ventral margin, becoming somewhat more prominent, and serving as a proper valve to the posterior cava; finally, it gradually disappears along the base of attachment of the Eustachian valve. This agrees tolerably well with the description of Vulpian and Philipeaux; and with Dr Watson's figure, though in the text of his description he says that the valve passed round the *upper* margin of the right anterior cava. A large Eustachian valve separates the posterior from the left anterior cava. The great coronary vein opens into the left anterior cava under cover of a pectinated muscle.

The two superior venæ cavæ in the elephant, as in monotremata, marsupials, many rodents, the hedgehog, and the bat, and by a rare deviation from the ordinary rule in the human subject also, are explicable as a retention of an embryonic structure very general in vertebrates. At first the blood is returned to the heart by an anterior (jugular) and a posterior (cardinal) pair of venous trunks, as well as by a median posterior, which persists and constitutes the inferior cava. The cardinal and jugular veins of each side unite to form a precaval or canal of Cuvier, and the two precavals are primitively united into a common trunk which enters the undivided auricle. The common precaval trunk ultimately forms part of the right auricle into which the two precavals then open separately, forming the right and left superior (or anterior) venæ cavæ. A transverse connection is next established between the jugular veins; the left jugular, below the transverse branch, and the left precaval contract and become obliterated; while the enlarged transverse branch becomes the left innominate vein, and the lower part of the right jugular together with the right precaval forms the single superior (or anterior) vena cava of the higher mammalia. The coronary sinus is, according to Mr Marshall, the only part of the left anterior cava which in these mammals remains pervious. (See Rathke, *Meckel's Archiv.* 1830, p. 63; and *Ueber den Bau und die Entwickelung des Venensystems der Wirbelthiere*, Königsberg, 1838; Bardeleben, *Müller's Archiv.* 1848; Marshall, *Phil. Trans.* 1850, part i.; and Owen, *Anatomy of Vertebrates*, vol. iii. p. 551.)

*Right Ventricle.*—The "incomplete septum" of Vulpian and Philipeaux seems to consist merely of the more or less united fleshy columns. In our example these differ considerably from the description of the authors just named. Four or five are attached, low down, to the external wall; three or four others, less distinct, from the ventricular wall to the interventricular septum. All the very numerous tendinous cords spring from fleshy columns, though these have not on the inner side of the ventricle any considerable free extent. No corpora Arantii are present on the semilunar valves of the pulmonary artery. The wall of the ventricle is cavernous towards the tricuspid valve, and also along a line leading from the apex to the orifice of the pulmonary artery, close to the ventral border of the interventricular septum. The tricuspid valve may have one or two (in our example two) small additional cusps.

*Left Auricle.*—The entry of the pulmonary veins seems to vary. Vulpian and Philipeaux found two openings into the auricle—a small internal and a large external; which latter received three of the pulmonary veins. Dr Watson describes four separate openings. In our dissection there was a large central orifice and a smaller one on each side—one internal and the other external; but the external vein was not altogether clear of the central one. A thin ridge upon the internal surface of the auricle separates the central from the internal orifice. The veins enter a thin and membranous sinus, which is slightly separated from the rest of the auricle by a prominent fleshy ridge. Part of the edge of this ridge forms the "valvular structure" noted by Dr Watson. The wall of the left auricle is strengthened, especially on the anterior and external sides, by numerous trabeculæ. The fossa ovalis is distinguishable only by a slight transparency.

*Left Ventricle.*—The mitral valve forms a continuous membranous ring, but indications of a separation into internal and external cusps are visible. Vulpian and Philipeaux found only two fleshy columns in the left ventricle—one above and the other below. We can distinguish four or more, all nearly on the same level, but divisible into an internal and external set. The aortic valves are continuous with the inner mitral.

*Coronary Vessels.*—Camper was probably mistaken in saying that there is only one coronary artery. Like several previous observers, we find two. The great coronary vein opens into the left anterior cava.

*Pulmonary Artery.*—Three dilatations, corresponding to the sinuses of Valsalva, are distinctly visible externally. The artery passes forwards, upwards, and to the left, curving round the aorta and dividing in the concavity of the aortic arch into two branches, one to each lung. The nearly obliterated ductus arteriosus passes obliquely from right to left, from the pulmonary artery shortly before it divides to the aorta, which it enters immediately to the left of the left subclavian artery.

*Aorta.*—The arch of the aorta gives off a very short innominate trunk, which subdivides into the right subclavian and the two carotids, and secondly, a left subclavian.[1] An *arteria thyroidea ima* proceeds from the point of separation of the two carotids.

We have traced the arteries throughout the body, but the details of distribution offer few significant features.

*Anterior Venæ Cavæ.*—Dr Watson observes that "each was formed by the junction of *three* large trunks a short distance in front of the arch of the subclavian artery. Of these, one came from the outside, a second came from the direction of the middle line, whilst an intermediate one passed directly backwards. The vena cava of each side, thus formed, passed directly backwards, receiving in its course several smaller veins, one of which was the trunk formed by the union of the companion veins of the mammary artery, and finally opened into the right auricle. In addition to these, the right anterior cava received the azygos vein immediately before piercing the pericardium. There was

[1] Cuvier and Mayer seem to have found three trunks, viz., right subclavian, carotid, and left subclavian. Hunter, Owen, Vulpian and Philipeaux, and Watson agree with the statement in the text.

no trace of a small or left azygos vein: the posterior cava, immediately after piercing the diaphragm, opened into the auricle."

## Veins and Venous Plexuses.

The most striking peculiarity of the veins lies in the plexuses and free anastomoses which occur in nearly all sheltered parts of the body. We find extensive plexuses in the superficial and deep temporal, pharyngeal, pectoral, anterior and internal femoral, popliteal, axillary, and brachial regions, besides less important communications elsewhere. The veins are in general large and capacious. In some cases, at least, valves are wanting in the plexuses, but we were unable to test the freedom of communication in different directions by a general venous injection.

*Superficial Temporal Plexus.*—This lies above the zygoma and behind the eye, beneath the temporal gland and superficial to the temporal muscle. Its communications are with the temporal vein by means of a superficial branch which crosses the posterior end of the zygoma, with the internal maxillary and facial veins, and with the deep temporal plexus. The temporal artery crosses the zygoma immediately behind the vein noticed above, and gives branches, which do not inosculate, to the area of the venous plexus.[1]

*Deep Temporal Plexus.*—On reflecting the *temporalis* muscle, a large and intricate venous plexus is seen. The largest of the contributory veins cross the temporal fossa longitudinally under cover of the zygoma, and communicate in front with the interorbital veins. Two considerable branches pass in front of the neck of the lower jaw to communicate with the superficial temporal plexus, as also do some smaller branches at the anterior border of the *temporalis.*

*Pterygoid Plexuses.*—There is a complicated network of veins overlying the *pterygoideus externus,* and communicating (1) with the longitudinal veins of the deep temporal plexus; (2) with the internal maxillary vein; and (3) with the superficial temporal

[1] Neugebaur has described a temporal venous plexus in the goose (*Nova Acta,* vol. xxi. p. 521. 1845). In Froriep's *Notizen,* Oct. 1832, p. 39, Otto has described the superficial temporal plexus of the elephant as *arterial,* an error corrected by Dr Watson. The same mistake is repeated in Owen's *Anatomy of Vertebrates,* vol. iii. p. 548.

plexus, by means of the veins passing in front of the neck of the lower jaw.

When the *pterygoideus externus* is reflected, a free anastomosis of large veins is found, which receives branches from (1) superficial temporal; (2) deep temporal; (3) superficial pterygoid plexuses; (4) inferior dental veins; (5) venæ comites of meningeal artery. The plexus discharges into the internal jugular vein by four large trunks.

*Pharyngeal Plexus.*—This lies at the back of the mouth, and has been noticed in the description of the pharynx. On each side it receives muscular and vertebral veins; the internal jugular, with lingual, muscular, and facial branches; the internal maxillary; and a descending palatine vein. A single transverse branch connects the plexuses of the two sides.

*Pectoral Plexus.*—Beneath the *pectoralis* is a plexus of great extent and intricate arrangement, which effects communications with the intercostal, internal jugular, axillary, and internal mammary veins.

These particulars will probably suffice respecting vascular arrangements whose physiological interpretation is as yet so obscure. The plexuses of the extremities lie usually in the hollows of joints, and are both numerous, intricate, and capacious. Our notes and drawings preserve many details which it is not thought needful to describe in print.

Van der Kolk and Vrolik,[1] Hyrtl,[2] and others[3] have collected many examples of vascular plexuses in vertebrate animals, and have suggested several possible theories of their physiological effect. It seems necessary to distinguish and classify before any explanation is attempted, for no single explanation can possibly apply to all the recorded cases. Arterial and venous plexuses must be carefully separated, though this has not always been attended to. With respect to the arrangement of their component vessels, some plexuses arise by the breaking up of a trunk into many small branches, which subsequently reunite, and may be compared to a rope untwisted in the middle (*funi-*

[1] "Recherches sur les plexus vasculaires chez différents animaux," Zool. Soc. of Amsterdam, transl. in *Ann. Sci. Nat. Zool.* 4e sér. tom. v. p. 111 (1856).

[2] "Neue Wundernetze und Geflechte bei Vögeln und Säugethieren," *Kais. Akad. d. Wiss. Math. naturw.* Bd. xxii. (1863). Also reprinted separately, 1864.

[3] Müller, Von Baer, Carlisle, Breschet, Milne Edwards, Turner, Murie, &c.

*form* plexuses). Others form a network of communication between different vessels (*retiform* plexuses). Others, again, are due to the sudden breaking-up of an artery into many small branches, which may anastomose, but do not reunite; or to the entry of many small veins into a common trunk at or near the same place (*distributive* plexuses).

Such plexuses as we have seen in the elephant are all venous and retiform. We have no confident opinion respecting their physiological meaning. It may be worth while to remark that they are so extensive as to constitute in the aggregate a not inconsiderable reservoir of blood, which may remain nearly motionless, or move sluggishly when the animal is at rest, but must be impelled towards the heart by energetic contractions of the adjacent muscles. The small development of the lymphatic system is also an important, and not impossibly a related fact. The lymphatic glands are few and small, and the thoracic duct was not, in our example, materially larger than in an adult man. That the venous blood lodged in these many plexuses may have an absorbent office is a possible view, but one upon which we do not venture to lay emphasis.

## RESPIRATORY SYSTEM.

### LARYNX.

The thyroid consists of two rhomboidal alæ, whose superior and inferior borders respectively converge forwards to the middle line at an obtuse angle. They are continuous in front for the upper half of their depth, and strongly connected by yellow elastic tissue in the lower half. The cornua project very slightly. To the postero-superior angle the cartilaginous tip of the thyro-hyal is articulated by a capsule lined with synovial membrane; the postero-inferior angle is similarly connected with the prominent lateral facet of the cricoid cartilage. The cricoid and arytænoid cartilages differ in no material respect from the same parts in man. Professor Owen observes that "the cricoid extends posteriorly over the first three tracheal rings."[1] This is not the case; the three upper rings of the trachea are obliquely

[1] *Anat. of Vertebrates*, vol. iii. p. 591.

cut off behind, and their edges are connected with the lower border of the cricoid. The epiglottis is very thin and flexible.

The *crico-thyroidei* are closely united in the middle line (C. and L.—261, fig. 2, $z^1$). *Crico-arytænoideus posticus* passes vertically to the base of the arytænoid cartilage, and the muscles of opposite sides blend. There is no *cerato-cricoideus. Arytænoideus* consists of a single set of fibres, which converge from each side to a transverse median tendon. The upper fibres are continuous with *thyro-arytænoideus,* so that the two muscles form a complete ring round the larynx. *Crico-arytænoideus* springs from the upper half and edge of the side of the cricoid cartilage; it is almost continuous with *thyro-arytænoideus* towards its insertion. *Thyro-arytænoideus* arises from the whole depth of the thyroid cartilage in the middle line, including the elastic tissue which closes the inferior vertical notch. The fibres pass downwards and backwards, to be inserted into the outer and posterior surfaces of the arytænoid cartilages. The muscle is continuous behind with the upper fibres of *arytænoideus.* No depressor of the epiglottis was made out. *Hyo-epiglottideus* (elevator of the epiglottis) is a strong muscle arising close to its fellow, from which it is separated by a septum of yellow elastic tissue. It springs from the basi-hyoid close to the middle line, and passes directly backwards to the anterior surface of the epiglottis, having a length of about three inches. The two muscles underlie the thyro-hyoid membrane and support this part of the floor of the pharyngeal pouch. Camper's drawing (pl. xii. fig. 4) is fairly correct, except that he does not indicate any separation of the muscles of opposite sides.

The upper or false vocal cord is rounded and hardly apparent except behind. The lower is straight and well-defined, with a sharp vibratile edge. A small laryngeal pouch leads backwards from the ventricle, and extends for a short distance under cover of the antero-external border of the arytænoid cartilage.

The superior laryngeal nerve pierces the anterior border of the thyroid cartilage near its centre.

Below the arytænoid cartilages and vocal cords the internal surface of the larynx is covered with longitudinally wrinkled yellow elastic tissue similar to that of the trachea. The mucous membrane above the vocal cords resembles that of the pharynx.

## TRACHEA.

The trachea consists of about thirty rings. These are incomplete behind, and occasionally subdivided, the joints being enclosed in synovial capsules. The tube is lined by yellow elastic tissue thrown into firm and very narrow longitudinal folds. The space between the ends of the rings behind is occupied by two distinct layers of unstriped muscle, the outer layer being transverse and the inner vertical in the central part, but radiating outwards laterally.

## BRONCHI.

"The right bronchus consisted of eight, the left of six rings. In addition to these, however, there were several cartilaginous nodules of small size representing rudimentary rings. No accessory bronchus, such as is so common among the ruminants, was met with, the azygos lobe of the right lung receiving its air-tube from the right bronchus after it had entered the substance of the lung."—(*Watson.*)

## LUNGS.

The shape of the lungs is adapted to the deep and narrow thorax; the whole of the ventral surface is in contact with the diaphragm, which extends forwards to the second or third rib. The visceral and parietal layers of the pleura are closely connected together by matted elastic tissue, while the pleural sac is at the same time pretty generally adherent to the thoracic wall on the one hand and to the surface of the lungs on the other. The right lung, according to Vulpian and Philipeaux, has a small upper lobe, a triangular internal lobe, which rises towards the trachea, and a very considerable third lobe. Dr Watson found only two lobes, of which the smaller lay on the left side and projected transversely from the lung immediately below the hilum. In our example the arrangement was nearly the same. The left lung is undivided. The lobules are very easily separable. Dr Watson observes that the bronchi branch irregularly, and that upon entering the lung they immediately lose the cartilaginous laminæ. This was the case in our subject also.

## NERVOUS SYSTEM.

We are not able to give any useful information respecting the nervous system of the elephant. The brain was not removed until eight months after death, when its internal structure was much broken down. We have traced the chief nerves, but find no peculiarities sufficiently remarkable to justify a minute description.[1]

## ORGANS OF SPECIAL SENSE.

### EYE.

Mayer describes a special depressor of the lower eyelid, and Dr Watson confirms the statement. It arises with the *recti* and *obliqui* from the bony canal posterior to the orbit, and passes forwards beneath the eyeball to be inserted into the cartilage of the lower lid. Dr Watson notices also "a very extensive and well-developed periosteal muscle," which "corresponds exactly in position to the similar muscle in the sheep and deer."[2] The muscles which pass from the upper and lower eyelids to be inserted into the third eyelid are not, according to Dr Watson, distinct muscles at all, but fibres of the *orbicularis palpebrarum*.

Camper, Harrison, and Watson agree in stating that no true lachrymal apparatus is present. The Harderian gland lies between the inner wall of the orbit and the *rectus internus*; its excretory duct opens on the surface of the third eyelid.

### EAR.

The membrana tympani is of oval form, and looks downwards, outwards, and a little forwards. The malleus is attached above the centre to the apex of the shallow funnel, which, as in other mammalia, projects inwards from the tympanic membrane. The apex of the funnel is directed upwards and forwards. In our young example the long diameter of the membrane was $\frac{7}{8}$ inch, and the short diameter $\frac{1}{8}$ inch less. Sir Everard Home

[1] For the relative sizes of the cranial nerves, Dr Harrison's description may be consulted. Quoted (with figure) in Sir J. Emerson Tennent's *Natural History of Ceylon*, p. 95.

[2] Described by Professor Turner in the *Proc. Royal Phys. Soc.* Edinburgh, Dec. 19, 1861, and *Nat. Hist. Review*, Jan. 1862.

gives $\frac{17}{20}$ inch as one dimension, and rather more than an inch as the other.[1] This was probably from an adult animal. The middle layer contains the usual radiating and circular fibres. No peculiarity of importance was observed with respect to the ossicles.

## Nose.

The cartilaginous nasal septum continues forwards the plane of the vomer and of the perpendicular plate of the ethmoid. It ends in front by a tapering projection which extends in advance of the bony nares, and supports the alinasal cartilages. The cartilage of the septum is not prolonged into the fibrous and muscular septum of the proboscis. Its upper edge gives origin to a set of longitudinal muscular fibres, which increase in number below, and ultimately blend with the under surface of *levator proboscidis.* The same edge gives off on each side a narrow lateral process, continuous along the whole length of the septum, and to these processes the alinasal cartilages are attached in front of the bony nares by a simple hinge-joint, without synovial capsule. In our young example each alinasal cartilage measures four inches in length and less than one inch in width; it has a slight curvature forwards and outwards. Its external margin is connected with the bony nares beneath *levator proboscidis* by a thin, tough, and extensive sheet of fibrous membrane, which can be traced downwards into the lining of the air-tubes of the proboscis. The membrane is capable of distension, and forms a kind of pouch, which greatly enlarges the capacity of the nares at this point. Transverse muscular fibres, continuing the series of the radiating fibres of the proboscis, connect the sides and under surface of this pouch with the margin of the bony nares. Another set of transverse fibres (*dilator naris*), extending across the alinasal cartilage and taking origin from it, passes to the adjacent border of the pouch, leaving a clear space about an inch in width between them and the lower transverse fibres. This upper set (*dilator naris*) would, when in action, tend to raise the free or external edge of alinasal cartilage, and thus increase the capacity of the pouch, while the lower transverse fibres would assist them to enlarge the pouch by drawing its sides outwards. The alinasal pouch

[1] *Phil. Trans.* for 1800, p. 4.

is the only considerable chamber in the nose or trunk of the elephant; it may serve an important purpose in the storage of liquid. Behind the anterior bony nares we find a second lateral (aliseptal) cartilage. It is not perfectly continuous either with the nasal septum or the alinasal cartilage. It is connected with the former by a fibrous hinge-joint; with the latter by a strong elastic sheet, in which are a number of muscular fibres, which take origin from the upper border of the bony nares, and converge towards the fore end of the aliseptal cartilage. The position and form of this cartilage are those of a turbinated bone, but it is wholly unossified; its size is small in comparison with the relative development of the turbinated bones in most mammals. Its chief extension is in the direction of the nasal passage, and this dimension is about four inches in our specimen; the greatest vertical depth is two inches. The anterior half of the cartilage falls away outwards from the plane of the posterior half, so as to give rise to a decided step in the middle of the length. The general direction of the cartilage is vertical, but somewhat irregular, and the lower edge is rather nearer to the median plane (especially in its posterior half) than the upper. This aliseptal cartilage forms part of the outer wall of the nasal passage, as well as the inner wall of a transversely contracted channel which leads from the nasal meatus to a large frontal sinus. The muscular fibres attached to the fore edge of the aliseptal cartilage, which are continuous with the lower set of the transverse fibres of the alinasal pouch, when they contract, draw the cartilage towards the bony or outermost wall of the nasal chamber, and very effectually close the entrance into the air-sinus. The lower border of the cartilage, for somewhat more than the anterior half of its extent, is connected with the wall of the nasal chamber by a strong band of yellow elastic tissue, which forms part of the dividing septum between the proper respiratory passage and the entrance to the frontal air-sinus; it serves to antagonise the muscular fibres which close the valve. The posterior extremity of the cartilage is connected to the lateral wall by a mass of fibrous and mucous tissue, which forms the anterior boundary of the special respiratory chamber, and separates this from the channel leading to the frontal sinus. The aliethmoidal volutes are disposed in about seven laminæ, which gradually diminish in size backwards, and closely resemble the bony framework of the olfactory organ in the horse. Behind this point the nasal passage lies between the hard palate and the spheno-palatine surface. Its vertical extent in our young example is nearly three inches, but the transverse width is extremely small, and hence the nasal passages seen from behind present the appearance of greatly elongated vertical slits. (See p. 20.)

Dr Watson believes that the valve-like aliseptal cartilage is adapted to obstruct the flow of water into the air-sinuses of the skull during its passage along the narial tubes. We are disposed to question the normal passage of water along this highly sensitive tract. Examination of the parts discovers no valve or other provision for preventing water flowing from behind forwards[1] from gaining free entrance into the olfactory recesses. Moreover, the only important receptacle above the stomach is constituted by the pouch adjacent to the alinasal cartilage. We are inclined to suppose that the water lodged here (if, as we see no reason to doubt, the pouch in question actually serves as a receptacle for liquid) is pumped up through the proboscis, and never passes backwards beyond the anterior bony nares. The water which, according to the testimony of many observers, is regurgitated from the stomach, would, we imagine, be withdrawn exclusively by the tip of the proboscis inserted through the mouth into the pharyngeal pouch.

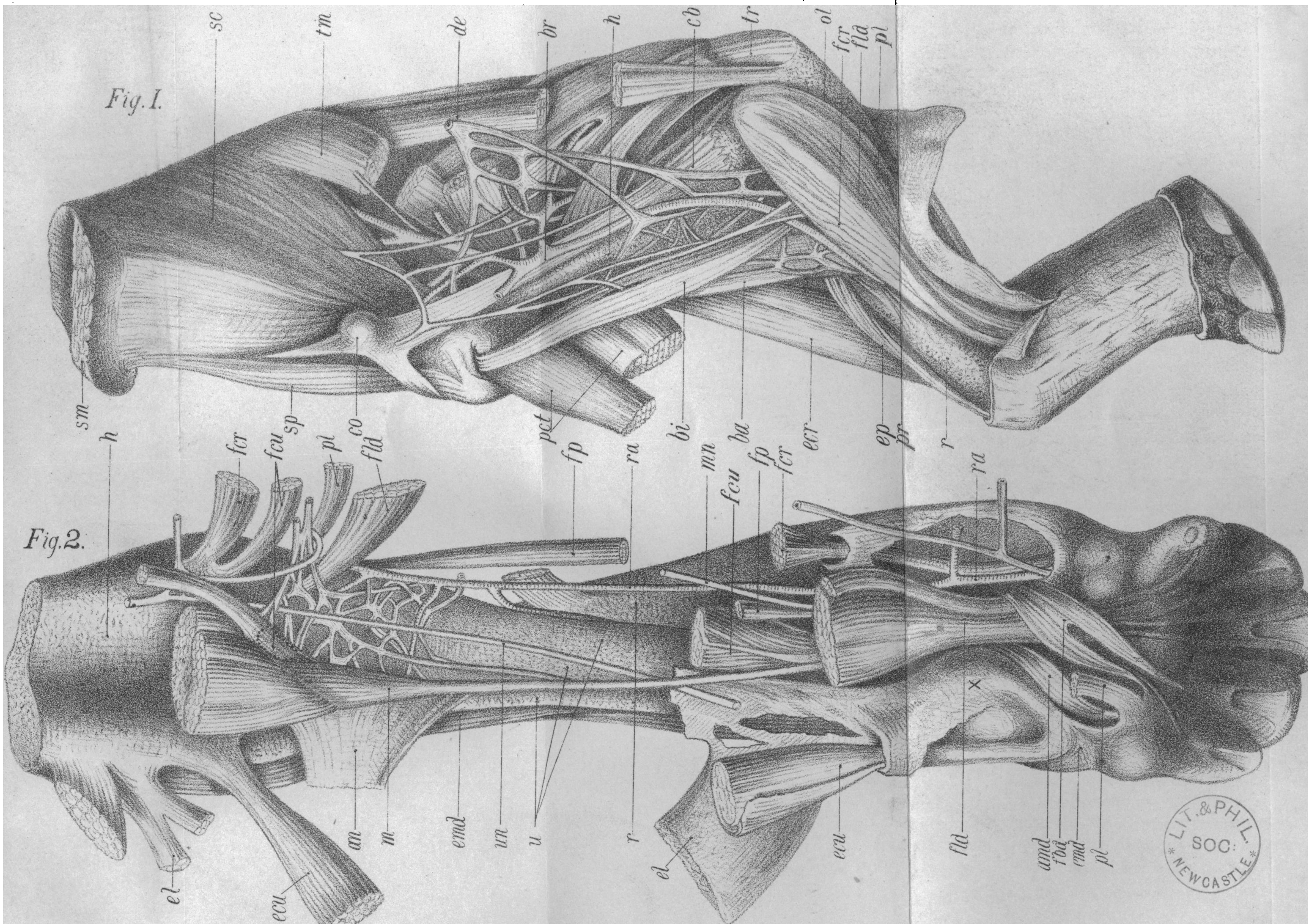
## CONCLUDING REMARKS.

It may be worth while to direct the attention of future dissectors to certain points, which have been passed over or inadequately treated by us. Most of these are superficial or easily made out, and it is to be hoped that the first opportunity may be seized of correcting our notes.

1. The cutaneous muscles should be redissected and more fully described.

2. The sterno-humeral and superficial cervical muscles (*pectoralis, masto-humeralis, sterno-maxillaris, sterno-mastoideus*) were insufficiently noted by us, and in the first hasty examination of the thorax, made before the possibility of a complete dissection

[1] See the quotation from Dr Watson's memoir on p. 24.



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was entertained, these muscles were mutilated beyond recovery. We have attempted to piece together and interpret the remaining shreds of muscle, but the results are not altogether trustworthy.

3. The large intestine should be studied microscopically while quite fresh.

4. The brain should be removed immediately after death, and minutely investigated. The parts liable to be injured in the process of extraction are now well known.

The difficulties attending the anatomical examination of a single example of a very large animal must be our excuse for many shortcomings. If we shall be found to have aided the next observer as much as Camper, Cuvier and Watson have aided us, we shall at least have repaid our debt. We do not doubt that much, very much, remains to be done before the structure of this single species is adequately made known. Minute and accurate knowledge of the anatomy of the elephant will be found of special value, and competent anatomists are happily not so few that we need grudge the time and labour which minute and accurate knowledge is sure to cost.

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## EXPLANATION OF PLATES.

### PLATE II.

Fig. 1. Inner side of right fore-limb. *h.*, Humerus; *co.*, coracoid process; *ol.*, olecranon; *r.*, radius; *sm.*, *serratus magnus; sc.*, *subscapularis; sp.*, *supra-spinatus; tm.*, *teres major; pct.*, *pectoralis; bi.*, *biceps; cb.*, *coraco-brachialis; tr.*, *triceps; de.*, *dorso-epitrochlearis; ba.*, *brachialis anticus; ecr.*, *extensor carpi radialis longior; ep.*, *extensor proprius pollicis; fcr.*, *flexor carpi radialis; pl.*, *palmaris; fld.*, *flexor longus digitorum; pr.*, *pronator radii teres; br.*, brachial artery.

Fig. 2. Flexor side of left fore-arm. *u.*, Ulna; *el.*, elastic ligament; *ecu.*, *extensor carpi ulnaris; fcu.*, *flexor carpi ulnaris;*[1] *an.*, *anconæus; m.*, see vol. xii. p. 271, line 5; *fp.*, *flexor longus pollicis; fbd.*, *flexor brevis digitorum; amd.*, *abductor minimi digiti; emd.*, *extensor minimi digiti; ra.*, radial artery; *un.*, ulnar nerve; *mn.*, median nerve. Other references as in fig. 1.

*** Fig. 2 is drawn on a larger scale than fig. 1.

[1] This should pass in front of *flexor longus digitorum*, to be inserted into the pisiform bone at ×.

## Plate III.

Fig. 1. Dissection of the root of the proboscis. Side view. *lp.*, *levator proboscidis* (reflected); *dn.*, *dilator narium; an.*, alinasal cartilage; *tf.*, transverse muscular fibres of alinasal pouch.

Fig. 2. Front view.

## Plate IV.

Section through nasal passages, pharynx, and larynx. *fs.*, Frontal sinus; *cc.*, cranial cavity; *e.*, Eustachian tube; *ph.p.*, pharyngeal pouch; *jc.*, Jacobson's canal; *bs.*, basi-sphenoid; *mx.*, maxilla; *pmx.*, premaxilla; *mn.*, mandible; *hy.*, hyoid; *an.*, alinasal cartilage; *as.*, aliseptal cartilage; *ae.*, aliethmoidal volutes; *th.*, thyroid cartilage; *cr.*, cricoid cartilage; *cp.*, constrictor pharyngis; *s.*, hind edge of nasal septum.

*** The proportions, especially of the bony parts, will be found to differ from those of the adult elephant.

## Plate V.

Fig. 1. Uro-genital organs (female). General view. *sr.*, supra-renal capsule; *k.*, kidney; *b.*, bladder; *o.*, ovary; *u.*, uterus; *v.*, vagina; *ug.*, uro-genital canal; *cl.*, clitoris; *r.*, rectum.

Fig. 2. Ovary and commencement of Fallopian tube. *o.*, ovary.

Fig. 3. Commencement of uro-genital canal (laid open). *h.*, hymen?

Fig I.

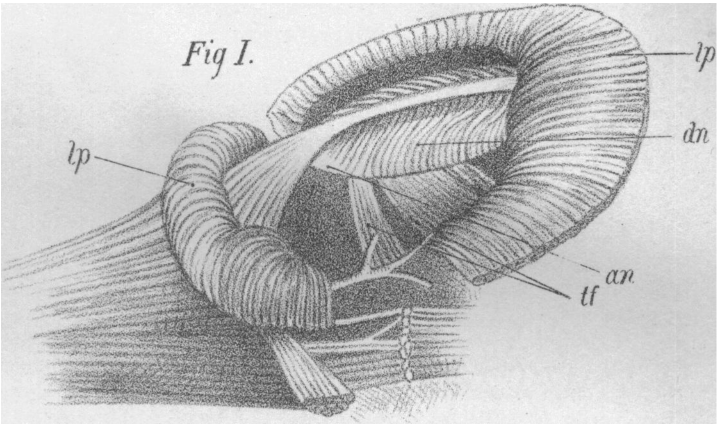
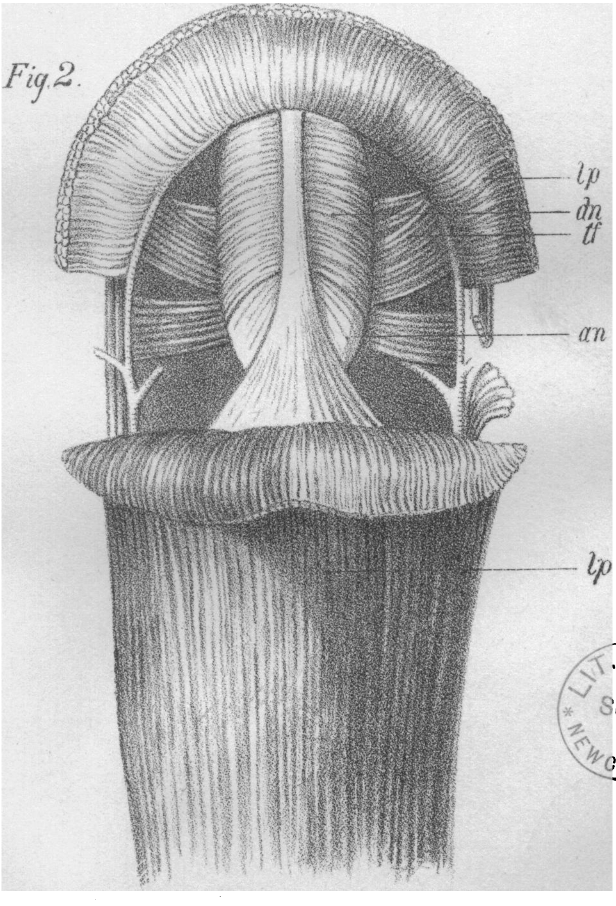



Fig. 2.



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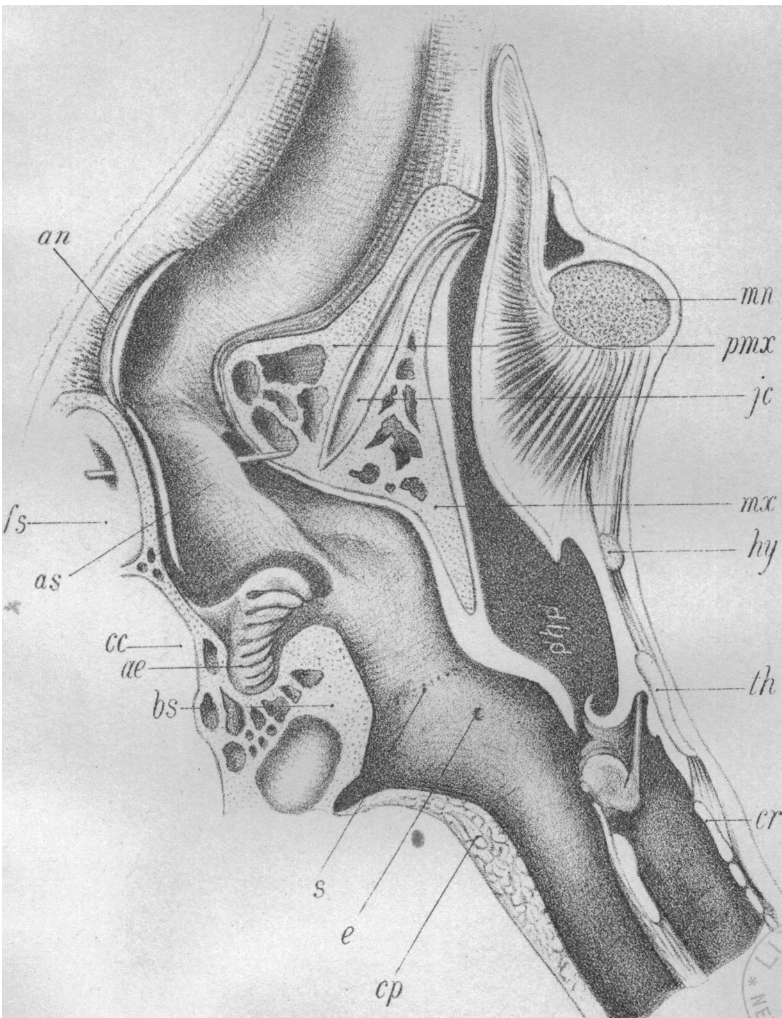


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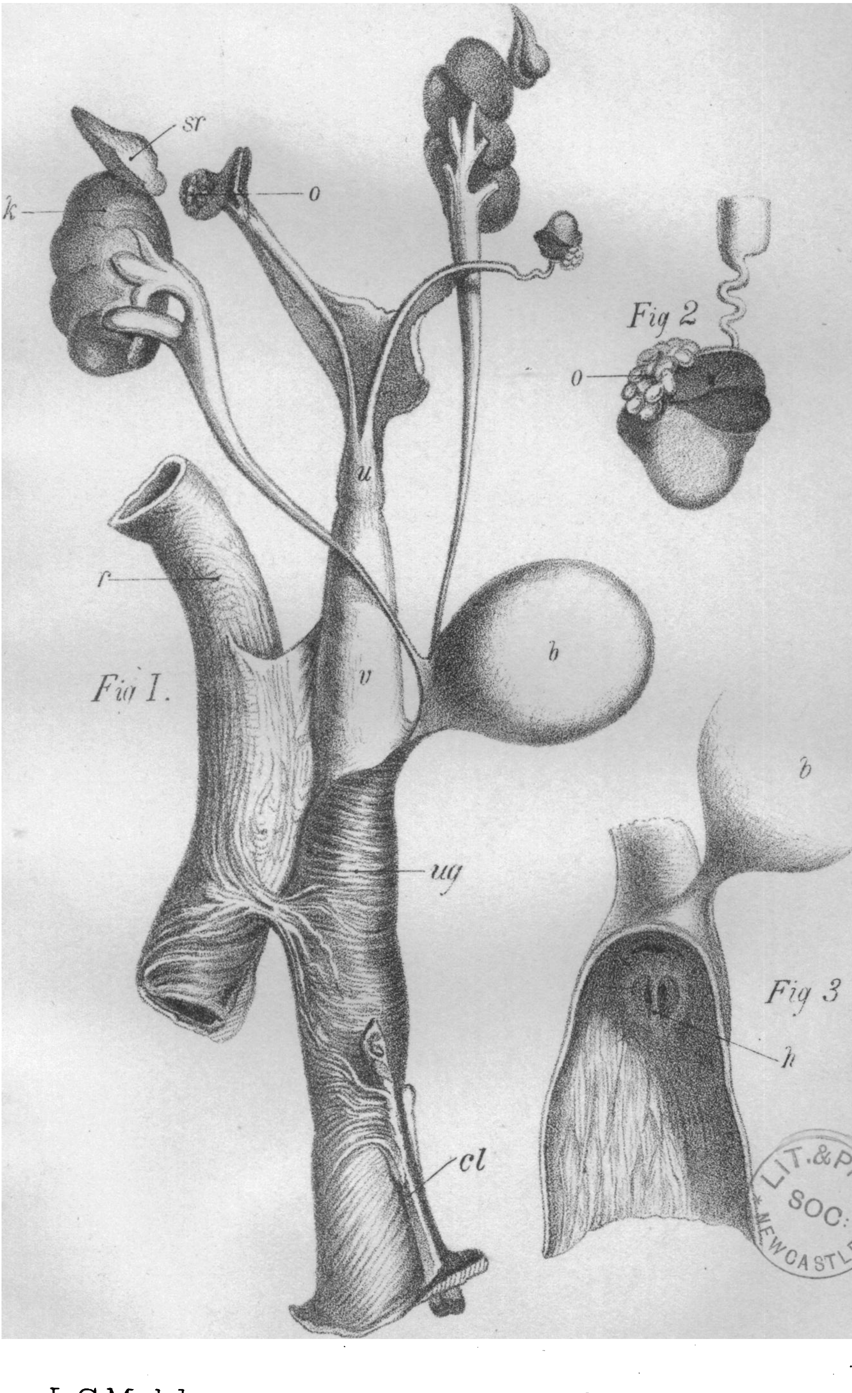




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